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The Effectiveness of Developing Endurance Ability on some Special Physical Variables and the Digital Level for 400-meter Hurdles Female Players (Analytical Research)

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Introduction:

Sports training moved with great strides in the science path, where it has recently been associated with the use of sciences that affect its operations for the continuous development of modern sports training. It relied in its development and progress on scientific foundations to raise sports performance rates and the level of achievement, which made modern sports training the most important pillars of reaching higher levels, competition, and achieving the desired sporting accomplishments. Athletics had a large share of impressive developments in results and levels in recent times, as it witnessed a global development in breaking records until it reached the extent of human miraculous.

Scientists and specialists in the sports training field sought to search for the achievement elements related to the type of training used according to the physical requirements and conditions imposed by different sports in general. Athletics events in particular managed through benefiting from the applied theories and research results of other sciences, including mechanics, physiology and psychology, which are directly related to the science of sports training, it was able to develop its outstanding achievements in recent years (24: 78, 79)

Bastawisi Ahmed (1997) indicates that ability is relatively the most important physical component in hurdles races in general, and what is focused on and developed during the special preparation period. As for the 400m

hurdles race, the focus is on developing speed, speed endurance, ability and strength endurance. Muscular ability (strength characterized by speed) is one of the most important physical factors affecting the physical performance levels of players, and it is the result of merging strength with speed. Owais El Jabali (2000) also mentioned that the combination of physical abilities is the basis for developing performance in the specialized activity, with the suitability of mixing these abilities, especially muscular ability (9: 346,347) (4: 131).

Owais El Jabali and Tamer El Jabali (2013) explain that the muscular ability concept is no longer limited to being just a type of muscular strength. Rather, scientists and authors from developed countries look at the concept of ability as a future in itself that has types and forms, and it has its own training methods, as it depends on some functional, genetic and neurological characteristics (10: 319).

Bill Foran (2001) indicates that the result of obtaining strength from the use of resistance training is through one of the following methods:

1. Circuit training based on body weight as resistance.
2. Exercises that depend on the resistance of the elastic ropes.
3. Training using kinematic devices through exercises similar to movement.
4. Training using additional weights such as (jacket weights - medical balls)
5. Weight training as resistance such as (Olympic lifts - exercises similar to movement using free weights).
6. Plyometric exercises such as (depth jump - jump over hurdles) (18: 153)

Many training scientists believe that "plyometric training" is the link between muscle strength and ability, and it is the main entrance to improve the performance level through the development of these two characteristics, as it works to direct its appropriate paths to push the performance speed level. They are those exercises during which the muscle is able to reach the maximum force production in the least possible time and it uses the gravity force to store energy in the muscles and then this energy is used directly in the reaction in the opposite direction. (8: 531-536) (11: 300)

Adams K, et al. (2001) mentions that plyometric training has achieved remarkable success in recent years because of its importance when lacking strength training and strength characteristic of speed; this is because it is performed with the explosive movements necessary in running competitions,

jumping, throwing, and the activities that its performance nature requires elevating high (17:33,34).

One of the new concepts of physical abilities in the muscular strength field, that is directly and closely related to muscular ability, is the "Endurance Ability" concept or term, which reflects the extent of the interrelationship of the three basic physical abilities (strength - speed - endurance) and is represented in trying to perform exercises that require a great deal of speed and explosive speed while continuing to do so for a relatively long period, as this period reflects the extent of the essential interrelationship between the characteristics of strength, speed and endurance. (25:30)

Bomba.T (1999) sees that endurance expresses the ability to perform muscular contractions characterized by an explosive nature for the longest possible period of time. He also believes that the player's possession of the characteristics of maximum strength, maximum speed and muscular endurance for a medium and long period allows the player to the highest levels of endurance exercises, taking into account the compatibility and agility level. He adds that the endurance development requires performance (15-30) repetitions with intensity ranging from 70%-80% continuously with great rest periods, while Miky Fry sets performance period (10-90 seconds) (19: 192-196) (22: 13).

Tamer El Jabali (2009) mentions that " Endurance Ability" is the player's ability to generate explosive muscle contractions for the longest possible period according to the nature and type of sports activity, and this is a training ability in the first place before it is a competitive ability. He also mentions quoting "Bastawisi Ahmed" (1999) that endurance ability is an important physical component in the field and track competitions that require repetition of a repetitive skill, such as running in the races of 200m, 400m, 100m hurdles and 400m hurdles, which require high effort repetition in the least possible time and also sports that require high endurance performance. Endurance is a concept that expresses the extent of the player's endurance, the ability to generate the appropriate force for the longest possible period, and it is the ability that the players in field and track competitions , especially hurdles and running are distinguished with. Physical component is considered the most important in hurdles races to be focused on and developed during the special preparation period, so that the focus is on developing speed, speed endurance, ability and endurance ability. (7: 74-123) (4:131- 136) (28)

Bomba.T (1999) indicates that during the planning of training loads for the development of endurance ability exercises are used with intensity (50-70%) of the maximum strength, with the requirement of the rhythm availability and explosiveness in performance, as is the case in dynamic muscle contraction, this requires work with (20-30) continuous repetitions and reaching a high level of endurance capacity. This necessitates that the training load characteristics start with a low level of (8-15) repetitions and then begin to increase after the adapting process to the training load occurs in the first period (4-6) weeks until it reaches (20-30) repetitions. This concept is related to the fatigue characteristics in players, especially central nervous fatigue and fatigue resulting from the accumulation of lactic acid, which requires this type of training to use a large rest between groups, which reaches (5-7) minutes (19: 193).

The 400m/h race is considered one of the strongest races that require different types and amounts of muscle activity, which depends on an essential element, that is endurance ability and the anaerobic energy production system, which mainly depends on the phosphate system and the lactic acid system. It depends mainly on the characteristics of "ability"; the player's ability in the hurdles race is at its peak during the elevation process to cross the hurdle, where the player repeats this process during the surpass of the ten hurdles distributed over the race distance, which requires the players to generate an explosive ability every time to cross the hurdle "elevation ability". In addition to the need to maintain the steps pace between the hurdles at the same speed and frequency rate, which requires the players to reach a high degree of acceleration ability, requiring the availability of a running ability level and "Endurance Ability" during the different stages of the race. (5: 65) (2: 84)

After conducting a comprehensive survey of the players' local digital level of this race and comparing it with the international digital level; a large gap was found between the Egyptian numbers and the Arab, African and international numbers with difference around 8 seconds.

Egyptian Number	Arab Number	African Number	International Number
1:01:43 minutes	52:90 minutes	52:90 minutes	51:46 minutes

This decline in the digital level results from the endurance ability component weakness which affects the number of steps used and the weakness of the ability to elevate during surpassing hurdles, also the inability

to maintain the same speed and ability rates during the sprint in the race's different stages.

After calculating the steps accomplished by the players over the race course according to their performance analysis, we find that:

The player needs from the starting line to the first hurdle 24 steps in the first 45 meters distance, and needs 17 steps between each hurdle during the 35 meters distance between each hurdle. She also needs 22 steps during the last 40 meters from the last hurdle to the finish line.

By calculating the steps number of the athletes, we find that:

24 steps + 17 steps x 9 hurdles + 22 steps = approximately 200 steps, which is a very large number as all of them must be performed with a high level of ability and speed.

Many scientific references and applied research have indicated that the repeated elevation of the 400-meter hurdles require a high strength ability and speed to complete the race in a highly technical manner, and because the decline in the speed element will negatively affect the race's kinematic variables, as well as the decline in the force element that negatively affects on the repeated push process during the race. In addition to the player facing a high level of fatigue as a result of the repeated hurdles surpassing, which starts from the fifth hurdle and continues until the last one, thus, hinders the player's performance. The player must maintain speed and ability rates under the condition of continuous work with high intensity load that works to develop the player's ability to resist fatigue and improve his physical and vital functions (15) .

Hence, the researcher finds that improving the endurance component will positively affect the speed during the sprint stages, the used steps number throughout the race, the step length, the step average frequency, and also the players' ability to maintain some degree of endurance ability during the completion of the last race distance, which affects the inter-distances spaces and race total time and the race physical elements development.

Research Objectives:

Identify the effect of strength endurance training on:

1. The physical variables of the 400-meter hurdles are under study.
2. The digital level for the 400m hurdles female players.

Research Hypotheses:

1. There are statistically significant differences between the pre and post-measurements in favor of the post-measurement in some physical variables related to the 400m hurdles race under study.
2. There are statistically significant differences between the pre and post-measurements in favor of the post measurement in the digital achievement level of the 400m hurdles race.

Research Procedures:

Research Methodology: The researcher used the experimental method using the experimental design with a pre- and post-measurement for one experimental group "analytical study" in order to suit the research nature and its procedures.

Research sample: The sample was chosen in the purposive way from Al-Zohour Club 400m/h female players under (18) years old, whom are ranked among the best three champions in Egypt for the 400m/h race during the 2022 season.

Data Collecting Tools:

First, Used Tools:

1. A measuring tape and chalk to measure the jump.
2. Stopwatch and whistle.
3. Medical balls of multiple weights.
4. Boxes of multiple heights.
5. Height-adjustable hurdles.
6. Plastic cones.

Second: The Physical Tests Used in the Research: Attachment (1)

After reviewing the references, studies and specialized scientific research such as "Mohammed Hosni" (2015), "Tamer El-Jabali" (2005), "Mahmoud Hamdy Mahmoud" (2015), "Ahmed Ismail" (2015), "Yasser Ismail" (2012) the researcher determined the most important tests that measure endurance ability:

1) Speed Tests:

- Maximum speed test 30m flying start.
- 120m speed endurance test, high start. (13)

2) Ability Tests:

- The wide jump test.
- Triple jump test. . (13)

3) Endurance Tests:

- Jumping test over 15 hurdles, height 76 cm, distance of 1 m.
- Hopping test for maximum distance. (12)

Third: Digital Level Test for the 400m/h race.

Steps to Implement the Main Research:

First: Pre-Measurements:

It was conducted in the time period from 13-14/1/ 2022; where the physical variables were measured on the first day and the digital level of the 400m/h race was measured on the second day.

Second: The Main Study:

The main study was conducted during the period from 15-1-2022 to 30-3-2022 for (10) weeks, where the researcher implemented the training program using endurance ability exercises using the plyometric method and running with resistance as an experimental variable for the proposed training program with (4) training units per week and (120 s) duration for the training unit of the experimental group for the research sample.

Third Post-Measurements:

The post-measurements were conducted for the experimental group research sample, for the variables under study in the period from 1-4/4/ 2022.

Statistical Procedures:

Determine the change and improvement percentage for the variables under study.

Proposed Training Program:

The program included the proposed special exercises to develop endurance ability.

1. The program period included two and a half months at (10) weeks rates; each week include (4) training units and the training unit time is (120 s).
2. The exercises consisted of training with rubber ropes, running with resistance (by skiing), and training with medical balls of different weights.

3. Some exercises were also done on hurdles and boxes of different heights during plyometric exercises to develop ability.
4. Body weight was used through hops, push and deep jumps.

Running exercises with resistance in the first month was with a body weight load (20-30%) and (20-40 m) distance with (6-10 times) repetition and number of (3 sets), inter-rest (3 s) and rest for (6 s) between sets. On the second month, the load is gradually reduced and the focus is on the performance speed with an increase in the distance traveled. While during the use of plyometric exercises, 3 exercises were used, with a number of (20-30 repetitions) and a number of (2-3) groups and (5-7 s) rest periods with a low intensity. The intensity used is increased to reach the high intensity.

The Plyometric Exercises Used Intensity was also determined:

When using the plyometric training method, dealing with intensity and density varies from one exercise to another. For example, the deep jump at 76 cm or more height is considered a maximum intensity for female athletes of 400 m / h, as it matches with carrying the explosive ability to elevate to cross the hurdle in the race.

Whereas, the best exercises used for jumping using boxes are in heights (35-90 cm).

Table (1) The Height of Hurdles and boxes in the training program

Program		Box Height cm			Hurdle Height
Duration	Week	Intensity	With One Leg	With Both Legs	
General Preparation	1-2	40-50%	25cm	35cm	60cm
Special Preparation	2-4	50-80%	35cm	45cm	75cm
Pre-Competition	4-6	70-95%	40cm	55cm	91cm
Competition	6-8	70-90%	35cm	50cm	84cm

Plyometric Training Load:

Intensity: It is determined from controlling the exercise type within the program during the gradation from low to high intensity, and in the transition from jumps in place to deep jumps. The usual used intensity is (60-90%).

Size: The number of jumps or hops in which the body is in contact with the ground and depends on the training variables, the number of exercises and sets

and the difficulty degree so that (60-100) is considered a low load, (100-150) is considered a medium load and (150-300) is considered a high load so that the repetition number is appropriate within the limits of (10-30) repetitions. (21)

Table (2)
Proposed Training Program

Duration	Training stages		General Preparation		Special Preparation				Competition Period Preparation			
	Weeks		1	2	3	4	5	6	7	8	9	10
Training Load	High	90:100%										
	Medium	85:75%										
	Low	70:60%										
	Rest	35:55%										
Training Load	High	90:100%										
	Medium	85:75%										
	Low	70:60%										
	Rest	35:55%										
Plyometric Training Load	Level		Low		Medium: high				High			
	Size		2:4 Groups X 25:30 Repetitions		2:4 Groups X 15:20 Repetitions				2:4 Groups X 15:20 Repetitions			
	Rest in between		5:7 minutes		5:7 minutes				5:7 minutes			
	Training Number		4		4				4			
	Weekly Training Number		2		2				2			
Running with Resistance Training Load	Intensity		20-30% of body weight		15-20 % of body weight				10-15 % of body weight			
	Size		3 Groups X 6:10 Repetitions X 10:40 meters		2:4 Groups X 4 Repetitions X 40:60 meters				1 Groups X 3:8 Repetitions X 60:80 meters			
	Repetition Rest		2.5 minutes		5:6 minutes				11:14 minutes			
	Groups' Rest		5 minutes		10:11 Minutes							
	Weekly Training Number		2		2				2			

Low Load | Medium Load | Low to High Load | High Load

Results Presentation and Discussion:

Table (3) The Improvement percentages in the physical variables of 400 m/h player for the speed component (maximum speed and speed endurance) for the research sample (n=1)

Tests	Measure unit	Pre-Measurement	Post-Measurement	Improvement Rate
Flying Start	Sec	3:45	3:10	-16%
High Start	Sec	17:15	15:20	-13%

Table (3) shows the improvement percentage for the player between the pre and post-measurements of the maximum speed and speed endurance components. The improvement percentage in maximum speed was (16%), while the improvement percentage in speed endurance was (11%).

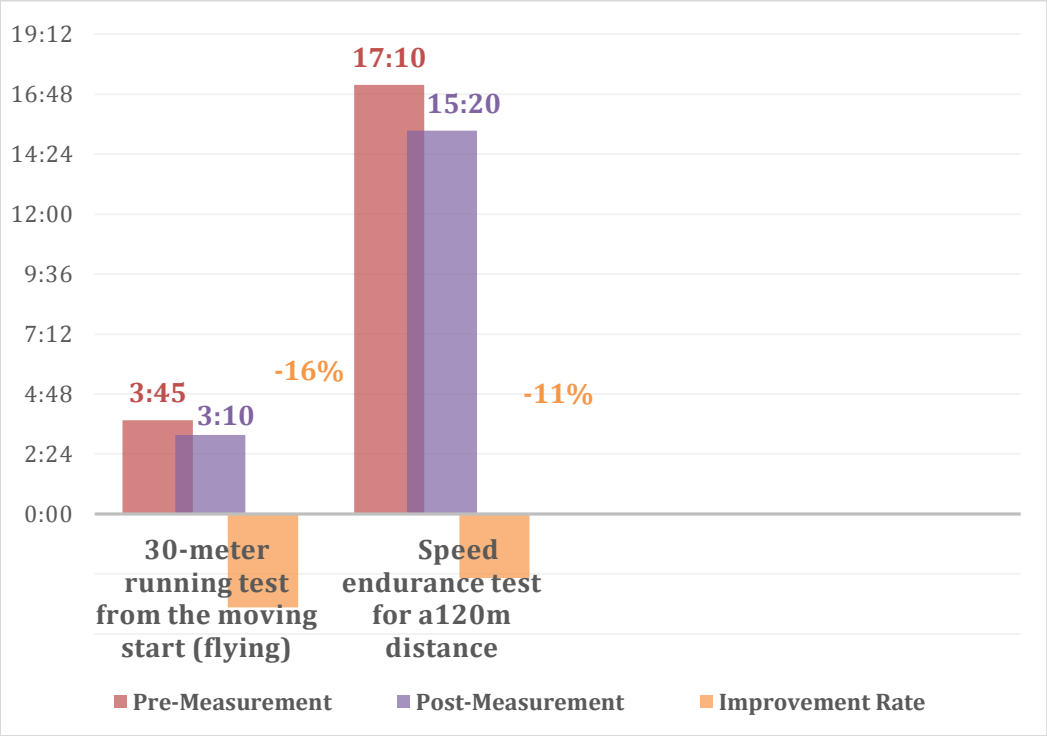

Figure (1) shows the improvement percentage for the player between the pre and post-measurements of the maximum speed and speed endurance components. The improvement percentage in maximum speed was (16%), while the improvement percentage in speed endurance was (11%).

Table (4) Improvement Percentages in the physical variables of 400 m/h player for the ability component (strength characterized by speed) for the research sample (n=1)

Tests	Measure unit	Pre-Measurement	Post-Measurement	Improvement Rate
Wide Jump	Minute	2:05	2:89	31%
Triple Jump	Minute	7:30	8:66	24%

Table (4) shows the improvement percentage for the player between pre and post- measurements of the ability components. The improvement percentage in the muscular ability for the triple jump was (24%), while the improvement percentage in the long jump ability was (35%).

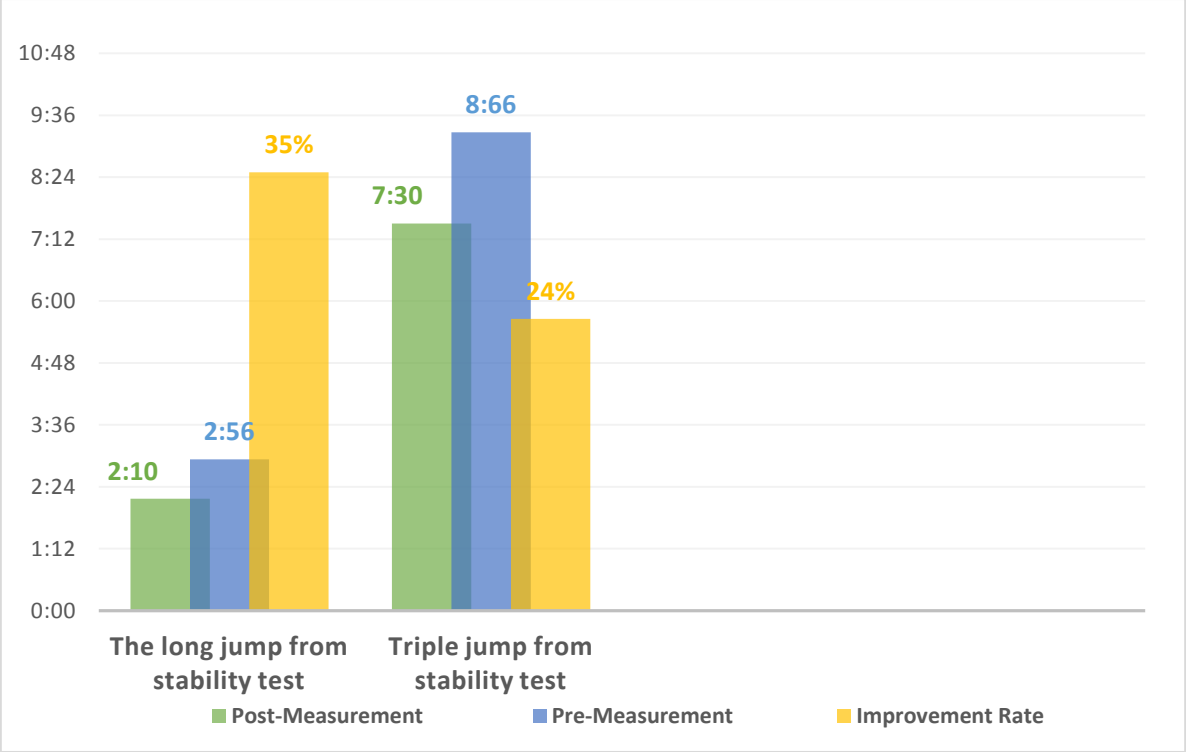

Figure (2) shows the improvement percentage for the player between pre and post-measurements of the ability components. The improvement percentage in the muscular ability for the triple jump was (24%), while the improvement percentage in the long jump ability was (35%).

Table (5) The improvement percentages in the physical variables of 400 m/h players for the endurance ability component of the research sample (n=1)

Tests		Measure unit	Pre-Measurement	Post-Measurement	Improvement Rate
Jumping over 15 hurdles		Second	15:30	12:10	-22%
Hopping to the max. distance	With right leg	Count	18	23	28%
	With left leg	Count	15	18	20%

Table (5) shows the improvement percentage for the player between the pre and post measurements of the endurance ability component. The endurance ability in jumping the highest hurdles was (22%), while the improvement percentage of endurance ability in hopping tests with the left and right leg for the maximum distance was (28%) and (20%).

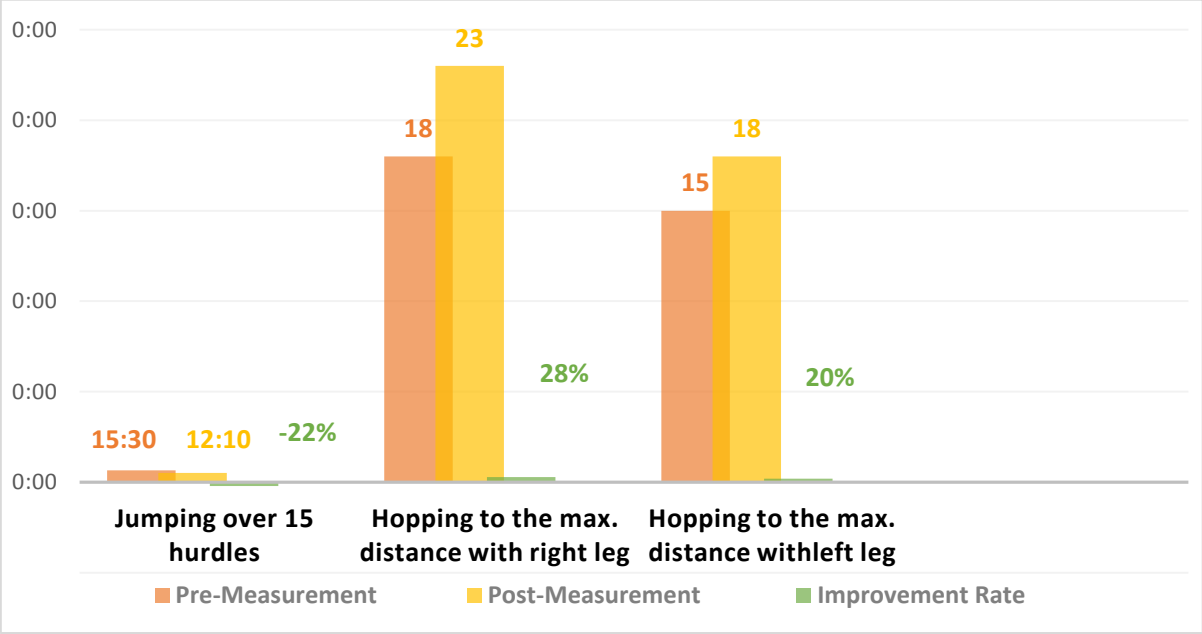

Figure (3) shows the improvement percentage for the player between the pre and post measurements of the endurance ability component. The endurance ability in jumping the highest hurdles was (22%), while the improvement percentage of endurance ability in hopping tests with the left and right leg for the maximum distance was (28%) and (20%).

Table (6) The improvement percentages in the digital level of the 400 m/h player the research sample (n=1)

Tests	Measure unit	Pre-Measurement	Post-Measurement	Improvement Rate
400 m/h digital level	Second	1:11:20	1:8:25	-4%

Table (6) shows the improvement percentage for the player in the research sample between the pre and post-measurements in the digital level for the 400m/h race, with an improvement rate of (4%)

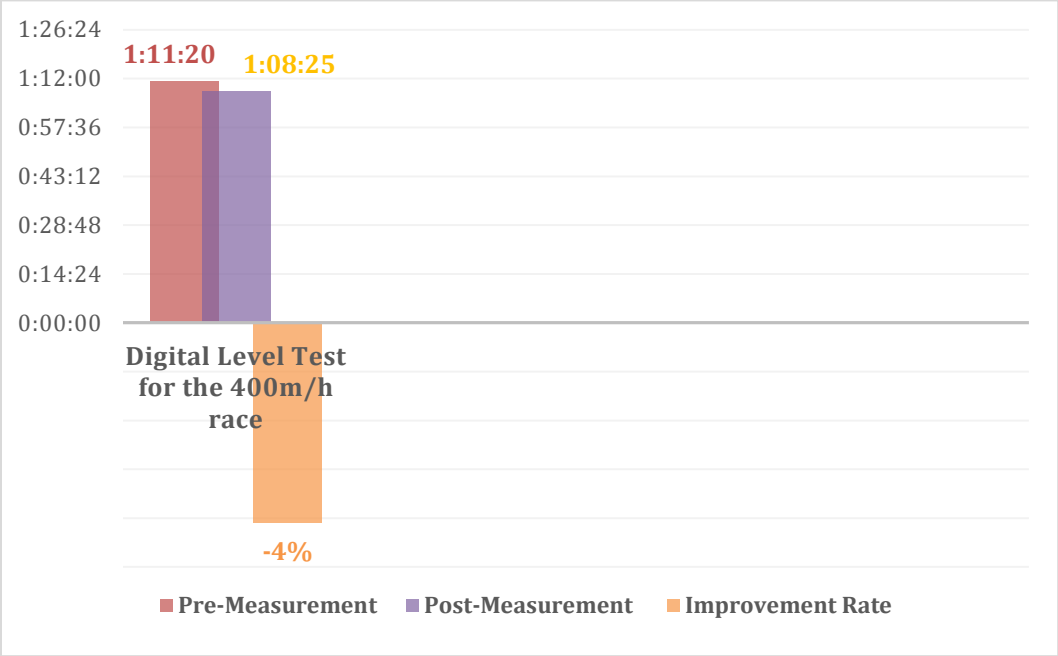

Figure (4) shows the improvement percentage for the player in the research sample between the pre and post-measurements in the digital level for the 400m/h race, with an improvement rate of (4%)

Results Discussion:

It was clear from Tables (3, 4, and 5) that there are statistically significant differences between the pre and post-measurements in favor of the post-measurement in some physical variables related to the 400m hurdles race under study. Where the improvement percentage varied between the pre and post-measurements for the maximum speed and speed endurance components; the improvement percentage in maximum speed was (16%), while the improvement percentage in speed endurance was (11%). the improvement percentage varied for the player between pre and post- measurements of the

ability components. The improvement percentage in the muscular ability for the triple jump was (24%), while the improvement percentage in the long jump ability was (35%). Also the improvement percentage varied for the player between the pre and post measurements of the endurance ability component. The endurance ability in jumping the highest hurdles was (22%), while the improvement percentage of endurance ability in hopping tests with the left and right leg for the maximum distance was (28%) and (20%).

The researcher attributes these differences to the effect of using (endurance ability) exercises that were used in a scientific and legalized manner. The researcher believes that achieving the best improvement percentage in muscular ability is due to the nature of the plyometric exercises used and resistance training components, which were directed to the physical variables improvement that strongly affected in endurance ability. This was confirmed by the "International Association of Athletics Federations" (2); "Bastawisi Ahmed" (4), where they pointed out that the 400 m / h race depends on a basic component, which is endurance ability.

This is in agreement with the results of Tamer Owais El Jabali (2008) (6), Iman Abd El Hussein Shandal (2010) (3), Ahmed Ismail (2014) (1), Medhat Abd El Hamid (2014). (15), "Mohamed Hosny Ibrahim" (2015) (12), "Mahmoud Ahmed Kasri" (2014) (14), "Paulo Jorge and Victor Manol Victor manual" (2004) (23).

This achieves the validity of the first hypothesis which states: There are statistically significant differences between the pre and post-measurements in favor of the post-measurement in some physical variables related to the 400m hurdles race under study.

Table (6) shows the improvement percentage for the player in the research sample between the pre and post-measurements in the digital level for the 400m/h race, with an improvement rate of (4%)

The researcher attributed this difference to the use of endurance ability training using plyometric exercises and running with resistance, which led to the physical abilities improvement, directly affected the improvement of the digital level of the 400 m/h race.

This result is in agreement with the results of "Eman Abd El-Hussein Shandal" (2010) (3), "Ahmed Ismail" (2014 AD) (1), "Medhat Abd El Halim Salem" (2014) (15), "Jensen" (2000) (20)

This achieves the validity of the first hypothesis which states: There are statistically significant differences between the pre and post-measurements

in favor of the post measurement in the digital achievement level of the 400m hurdles race.

Conclusion:

1. The training program for improving the muscular endurance ability component had a positive impact on the physical variables level related to the 400 m/h female athletes.
2. The plyometric exercises and the running training with resistance have a positive and effective effect on the improvement of the strength component in general and the ability and endurance ability component in particular.
3. The training program for improving the muscular endurance ability component had a positive impact on the digital achievement level for the 400m/h female athlete.

Recommendations:

In light of the research results and the conclusions reached by the researcher, the researcher recommends the following:

1. The need to focus on improving the ability and endurance ability of the 400-meter hurdles female players because of their impact on the race variables.
2. The need to develop the speed, strength and endurance characteristics for medium periods due to their close relationship with the endurance ability level and the performance nature in the 400m hurdles race.
3. The necessity of codifying and designing more training and tests related to the improvement of the endurance ability component.

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